Investigating the promise of lignocellulosic biofuels: Rice husks as non-human feedstocks

Sofia Kostrinsky, Arianna Soriano, Claire Martin, Dineen Vogler and Barnabas Gikonyo
Chemistry Department, SUNY Geneseo, Geneseo, NY. 14454

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Abstract:

The Earth has endured years of damage caused by an overuse of fossil fuels. Many are combating the damage with alternative energy. Biofuels represent an economical and often overlooked alternative to fossil fuels. Efforts have been geared toward the use of human food sources such as sugarcane (first generation biofuel). Although first generation biofuels aid in curbing greenhouse gas emissions, they lead to increasing food prices which negatively impacts developing countries. This research focuses on the production of second generation biofuels which relies on non-human food sources which exceed first generation biofuels in that they do not take away from a food source. This project specifically focuses on the use of rice husks as a biofuel feedstock. Second generation biofuels are also relatively inexpensive. The outermost layer that is separated from the rice grains during the milling process is usually thrown away as a waste product. Rice husks are ideal as a biofuel feedstock, because they cheap if not free, and they have the power to curb greenhouse gas emissions. For this project, an ionic liquid (1-Butyl-3-methylimidazolium chloride) was used for the pretreatment of the rice husks to yield glucose. Glucose quantification methods applied include refractometry, and DNS analyses.

Introduction :

The production of first generation biofuels has mainly been derived from food sources that are high in carbohydrates such as rice, bread, potatoes and other crops. The issue with first generation biofuels is that they take away from food sources and they cause the price of that food source to increase. As an alternative to the use of first-generation biofuels, research has turned to second-generation biofuels, which acquire ethanol from biomass. Biomass is renewable organic matter that can be used as a source of fuel.

Second-generation biofuels are made from lignocellulose, which is the inedible part of the plant's cell wall that is made up of lignin and cellulose. Cellulose and hemicellulose have the power to be converted into sugars such as glucose and xylose which is then fermented into ethanol. Ionic liquids are used in the pretreatment of biomass. Ionic liquids are essential towards aiding the breakdown of the biomass into cellulose, lignin and hemicellulose. The goal is to get the cellulose so that it can be converted into glucose and to eliminate lignin while retaining the hemicellulose.

Hemicellulose is a polysaccharide that is found in the cell walls of plants. Their main purpose is to strengthen the cell wall by interacting with cellulose, and in some cases, lignin. Cellulose is an insoluble substance which contains many chains of glucose monomers which is the main component in plant cell walls and vegetable fibers. Lignin is a group of aromatic polymers, which are primarily found in the walls of secondarily thickened cells. Lignin is a complex and heterogeneous mixture of polymers.

Ionic liquids are salts in which ions are not coordinated well, which results in them being liquids at a certain temperature. The use of ionic liquids in place of more traditional organic solvents is beneficial because it prevents the emission of VOCs, which is a major source of environmental pollution. Ionic liquids are also useful because they can help to maximize yield, selectivity, substrate solubility, and product separation.

Procedure

I. Biomass Preparation

Rice husks were purchased from from Rebel Brewer™, TN. The Rice husks were then washed in deionized water, chopped and dried in an oven at 70 degrees Celsius for a total of three days. The dried up rice husks were ground up using a mortar and pestle. The grounded up rice husks were then weighted using an electronic top-loading balance. Each sample contained 0.3 grams of ground up rice husk.

II. Ionic Liquid(IL) Pretreatment

The Ionic Liquid pretreatment involves 1-butyl-3-methylimidazium chloride. 1.5 grams of 1-butyl-3-methylimidazium chloride was weighed out using an electronic top-loading balance and placed in a 25 mL flask accompanying 0.3 grams of ground up rice husks. The ratio of Ionic Liquid to sample (rice husk) was 1:3 for each sample. The samples were placed in dishes filled with mineral oil and heated to 80 degrees Celsius for 3, 6 or 9 hours.

III. Acid Hydrolysis

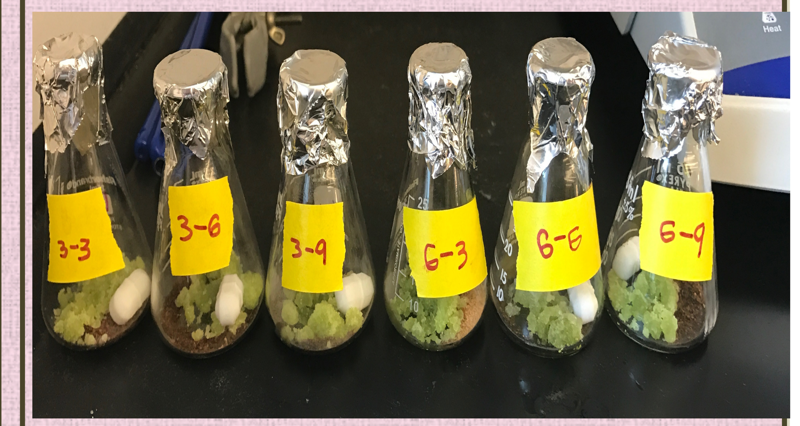
Each sample received 10.0 mL of 0.5 M Hydrochloric acid and a magnetic stirrer. The different samples were placed in dishes filled with mineral oil and heated to 80 degrees Celsius for 3, 6 or 9 hours. After each sample was removed from the mineral oil and cooled, 10.0 mL of 0.5 M sodium hydroxide solution was poured into each sample.

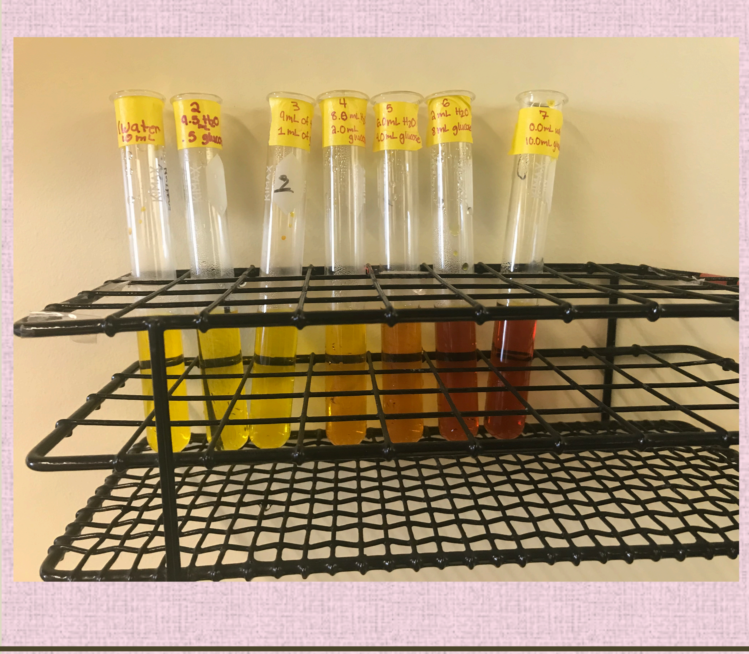
IV. Centrifugation

After each sample was cooled to room temperature, the samples were placed in a centrifuge for 10 minutes and spun at 2010 rpm. Then they were spun a second time for 5 minutes at 2500 rpm. Each sample was placed in a slot opposite of another in order for there to be a balance of masses

V. Filtration

After centrifuging the samples, a filtration set-up was made. The filtration set-up involved taking glass pipettes and breaking them at the elongated section (the tip of the pipette). Each pipette was filled with glass wool fiber, sand and charcoal. The glass wool fiber was inserted into the pipette first, followed by sand, charcoal, and then a small amount of additional sand. The charcoal is essential because it helped filter out the color of the sample from brown to clear. The liquid from the samples were then pipetted into each filter. The filtration set-up was repeated until all the liquid was filtered and came out completely clear.





Results and Further Directions

Future directions for this research project would include trying new ways to make the filtration process effective in a shorter amount of time. The brown liquid from the samples have to go through 3-4 rounds of the same type of filter (glass fiber, sand charcoal) before they come out clear. A new approach could include using different amounts of charcoal because it is an essential part of filtering out the color of the sample from brown to clear. The filtration set-up could also be changed to separating the make-up of each pipette, instead of using all three materials (charcoal, sand and glass fiber) together, there would be three separate pipettes containing one material each.

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